An Evaluation of Options to Optimize IT Infrastructure Costs

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Abstract

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Businesses are under considerable pressure to cut their daily costs. Various costs are discussed constantly at higher levels of management. This creates pressure for IT department employees to create solutions that answer to modern IT requirements. This includes being able to meet customers' requirements and business demands.

Many published research papers state that running IT infrastructure in the cloud is more cost effective than traditional IT infrastructure hosting. This has resulted in traditional hosting providers arguing heavily against it.

The objective of this thesis is to discover the most suitable IT infrastructure solution for the company to run with when a five-year plan is taken into consideration. This study will use methods such as comparison and evaluation to find the best new IT infrastructure. The three IT proposals are IaaS, On-premises and operating the business in the company's Y hosting.

When we are talking about on-premises we are referring to having a traditional server room in the same building as the company is working in. Hosting on the other hand means that server hardware is provided to the company on a monthly charging basis. IaaS stands for infrastructure as a service meaning that the virtual server is provided from a service provider to the company.

In the findings from the data analysis section this thesis reaches the conclusion that IaaS Azure is the most cost effective solution when the five-year plan is taken into consideration. The reason for this is that hardware gets outdated quickly and needs to be replaced. The recommendation based on the findings is that companies should increasingly start thinking about building their new IT infrastructure in the cloud.

One of the limitations of this thesis is that IT security policies are not taken into account when comparing and evaluating the three IT proposals; on-premises, hosting and IaaS Azure. Additionally, no frameworks have been used to determine the best new IT infrastructure solution for company X.

Keywords, Cloud, IaaS, Hosting, One-premises, Comparison, Evaluation, Cloud computing, IT proposals, Monthly, Investment, Migration, Costs,

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1 Introduction

A central topic in today's companies and organizations is cost reduction. Recently there has been a growing interest to reduce IT infrastructure costs. Cloud computing has been claimed to offer this solution to small, medium and large enterprises. According to Alton (2014) one of cloud computing's major benefits is that it offers enterprise quality technology to small businesses at an affordable price, thus raising the level they can compete in. This has led to a situation where it is possible to run a small business completely in the cloud (Alton, 2014).

Katz (2002) discusses that similarly with buildings and IT infrastructure has monthly constant costs and one-time and monthly operation costs. The difference between building and technology is IT becomes obsolete with a quicker speed and needs to be replaced or renewed, to survive and fulfill the company's business requirements. (Katz 2002)

Every situation in every company and organization is different, and how the IT infrastructure should be built depends on the company's or organization's future operations. Tsagklis (2013) discusses how cloud computing is a promising area for cost reduction when the IT infrastructure is operated in. Additional advantages Cloud computing has is that you no longer need to support the infrastructure or have extensive knowledge about maintaining and developing the IT infrastructure. This burden has been elevated to the cloud computing provider to take care of. This gives business more time to put more attention on core business activities when this types of aspects are outsourced to the cloud provider. (Tsagklis 2013)

Recent studies made about the extent of cloud computing state that the worldwide cloud computing market grew 28% to $110B in revenues at 2015 (cf. Columbus 2016). Synergy Research Group found that public IaaS/PaaS services attained the highest growth rate of 51%, followed by private and hybrid cloud infrastructure services at 45%. (Columbus 2016)

The purpose of this thesis is to discover the best IT infrastructure solution for company X that needs to renew their existing IT infrastructure. When comparing the options, a five-year plan is taken into consideration. For finding the best solutions for company X new IT infrastructure following IT proposals are compared and evaluated, between them on-premises, hosting and IaaS Cloud. Because of this the core audience of this thesis are companies and organizations that are considering hosting and cloud computing as an option to their new IT infrastructure.

The primary Aim for this thesis project is to help company Y to support the IT strategy of company X. The second aim is to increase understanding of cloud computing. The objective for this thesis are to evaluate the cost of the existing setup and a proposal for renewing the existing on-premises IT infrastructure setup for company X. This includes listing status of ex-

piry date, warranty, license, electricity, traffic and fixed server room cost. The second objective is to find the cost of operating the business in the in the IaaS cloud. This also includes finding the charging bases of IaaS Azure traffic, storage and availability. The third objective I have is to find the cost of operating the business in company's Y hosting. When hosting is discussed in this thesis it is referring to having all the servers in company Y server room. Similar as to having on-premises servers in company X office building they are in company Y server room or in a rented datacenter location. The last objective in this thesis is making a recommendation for a solution to company X's new IT infrastructure.

2 What is Cloud computing

The theory section of this thesis project is based on cloud computing literature and articles. When reading different literature books, articles and talking with IT professionals about cloud computing the conclusion is that cloud computing is here to stay. One of the reasons for this is the benefits that cloud systems can offer to the rapidly changing IT sector.

Sosinsky (2011, 3) states that "cloud computing refers to application and services that run on a distributed network using virtualized resources and accessed by common Internet protocols and networking standards." (Sosinsky 2011, 3)

Mather, Kumaraswamy & Latif (2009, 34) state: "The majority of cloud computing infrastructure consists of reliable services delivered through data centers and built on servers with different levels of virtualization technologies. "This services are available anywhere where there is internet. Cloud acts as a single point of access to any business or consumers computing requirements. (Mather, Kumaraswamy & Latif 2009, 34)

In other words, cloud computing is when you store and access your data through the internet instead of using it from your computers own local hard drive. In general cloud computing is when application, storage or service is hosted service are provided over the internet. Cloud computing can refer to servers, storages, applications or services that are provided over the internet. These services that are offered from the cloud are combined in different datacenters that are located all over the world, and are usually called the cloud. This gives businesses and customers the possibility to use the applications without installing any software in their local computer. The users are able to access their personal files and programs over the internet from anywhere because the cloud services are constant online. This provides the users the possibility to share information between different systems and with other users.

Hugos and Hulitzsky (2011, 45) discuss that cloud computing as a concept is nothing new. Already as early as in the 1960s, computer timeshare services were selling additional capacity

from supercomputers. However, what has changed since then is that the quickness, scalability and volume extra capacity is able to be delivered from one data center location to the end customer. (Hugos and Hulitzsky 2011, 45)

Cloud computing enables companies and organizations to pay of their actual usage of used IT resources. In a nutshell this means that companies rent the resources they need from the cloud instead of buying their own hardware.

What is nowadays brilliant with cloud server are that they act as depending of the demand were for example cpu or memory is scaled up or down in the control panel. Best of all this happens in seconds and in minutes with a click of a mouse button and you are charged based on pay as you go basis because of this cloud computing makes it highly flexible. Woodford (2015) gives a good example of cloud benefits, “if you run a fashion store and you have a time of peak demand coming up—an end-of-season sale, perhaps—you could double or triple the power of your machine for a week or two before scaling back down again when traffic returns to normal.” (Woodford 2015)

Daily used Cloud computing services in companies, organizations and by private users are Dropbox, Google Apps, Office365, Hotmail, Gmail and OneDrive. In these services files, emails and mobile/tablet apps are stored and maintained. These type of services and applications are running in different data centers all around the world, where they are synchronized and backed up constantly between datacenters. The backup datacenters can be turned on if the main datacenter starts having downtime issues.

2.1 Cloud Deployment methods

Sosinsky (2011, 7) defines that the “Deployment model defines the purpose of the cloud and the nature of where the cloud is located”. Cloud computing is possible to be run in different types of deployment models. Cloud deployment offer different types of availability, scalability, control and cost. Depending of organization or company’s requirements different deployment methods can be used as Public, Private, Hybrid or Community Cloud. (Sosinsky 2011, 7)

It is common for IT professionals and business executives that different cloud deployment methods terms get mixed up frequently. This is why most people are confused about them, which can explain why they are used inaccurately. On the upcoming sections, I will describe the different cloud deployment methods that are used and the advantages that they can offer.

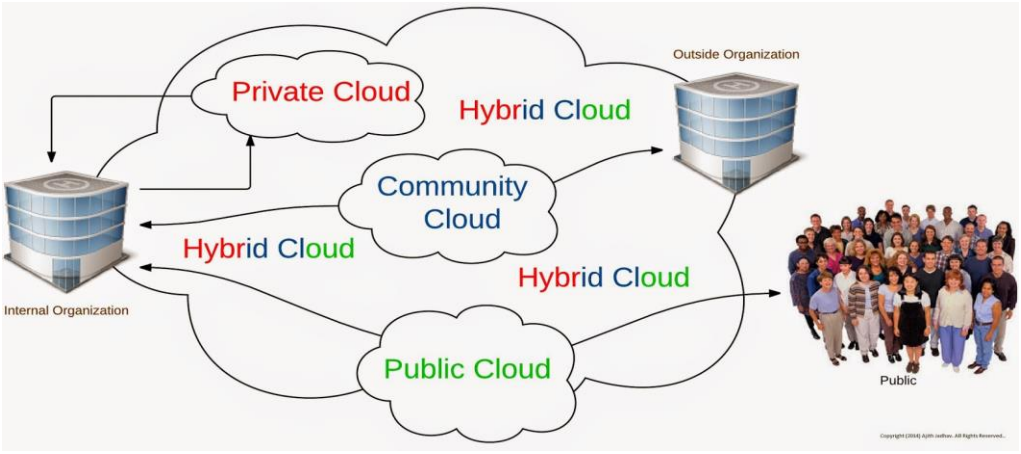

Figure 1. Cloud Deployment Models
(Jadhav 2015)

3 Public Cloud

Mather, Kumaraswamy & Latif (2009, 43) A public cloud "is hosted, operated, and managed by a third-party vendor from one or more data centers." These services are provided to multiple customers from multiple tenants under a shared infrastructure were it is accessible over the internet. (Mather, Kumaraswamy & Latif 2009, 43)

Public cloud model is the representation of what cloud hosting is, where the service provider offers infrastructure and service to different type of clients. For most of the customers Public Cloud is the most recognizable deployment model out on the Cloud market.

For those that are unaware of well-known public cloud software or applications, it could be worth mentioning a few different online document collaborations and email programs like OneDrive, Dropbox and Office365. Other Public cloud products that are widely used in companies and organizations are Google AppEngine, Azure Service Platform and Amazon Elastic Compute Cloud (EC2).

The main cloud providers that offers public cloud services out on the market are, AWS (amazon web services), Google, Azure and Rackspace.

3.1.1 Advantages of using public Cloud

The benefit the customer receives of using the public cloud, is that they do not need to invest a huge amount of money in building up an own on-premises IT infrastructure. This means that they are able to avoid the hassle of installing hardware or software if the company starts growing. They also do not need to care where the data is located and be doing the monthly IT

Maintenance routine tasks. From the company's perspective this again also saves them from the hassle of managing, buying and maintaining servers and hardware. This process is automated in the public cloud deployment service for the customer. This again provides for companies and organizations benefits as IT and business personnel can focus on other core activities which then increases the productivity, even when they are outside the office.

When public clouds advantages are stated by (Berg 2015, 8), "One of the major benefits is the seemingly unlimited number of resources available in a public cloud, we call this cloud characteristic scalability". If extra processing storage or power is needed on demand this is available without waiting anytime on delivery. The resources are available to end users by few clicks of the button. (Berg 2015, 8)

Victories (2015) describes public cloud as well suitable to companies and organization, that that need to manage work load of hosted application like SaaS (Software as Service), what most application consumers are consuming. Public Cloud model SaaS introduces the ability of running in decreased capital overhead of operational cost that makes it more economical. (Victories 2015)

3.2 Private Cloud

When (Berg 2015, 31), describes that private cloud is the opposite of public cloud. Difference with public and private is consumed by one organization. Private cloud infrastructure is usually located in on-premises or in a hosted data center that is operated by a service provider. Usual scenarios where private cloud is used are in large organizations were frequent demand is more common for new IT services. (Berg 2015, 31).

When comparing private cloud and public cloud the structure difference is that the storage, network and computing infrastructure is only offered to a single organization, and is not provided to any other organization. (Mather, Kumaraswamy & Latif 2009, 44).

Private cloud is well known as internal cloud where the platform for cloud computing is implemented, as a cloud-based secure environment. The private model provided is located behind a firewall, and where only authorized users are allowed to access the needed resources. This gives the organizations and companies IT personnel the possibility, to control access and data of different systems for the end users.

Private Clouds can be owned in-house or operated by a cloud computing provider. Private cloud utilizes the same technology as Public Cloud, the sole purpose being to maximize computing resources for the company or organizational needs. For some companies there can be

situations as operational, strategic or internal cultural reasons, why the company or organization wants to have their data in-house in the private Cloud. The ring fenced cloud model is ideal for those organization or companies, that needs to carry out sensitive tasks, process or store private data. Because of this private cloud is mostly used in financial companies.

To those organizations and companies that have unpredictable future IT demand, and having different types of monitoring security alarms, management demands and mission critical uptime 24/7 requirements. Private cloud is being considered to be most suitable for handling this task. The Private Cloud is able to fill the qualifications of better security policy requirements. But in those cases where a natural disaster or internal data theft happens the private cloud has it weakness. That needs to be take into consideration when implemented into the IT infrastructure.

3.2.1 Advantages of using private cloud

Santos (2012) justifies that “The reasons for using private cloud are cost reduction, enhancing service quality, and, more importantly, reducing the time it takes to deliver what users demand.” (Santos 2012)

Of all the Cloud deployment models out on the market, the private cloud is considered to be the closest one of traditional model of virtualized servers and LAN networks. Private Cloud is able to offer a variety of different advantages to organizations and companies, such as concerns regarding security data, governance and performance management. Additional benefits private cloud introduces are enhanced service quality, automation, cloud bursting, flexibility, cost reduction and reduced time given to deliver services for the end users. The best of all this enables IT organizations to use their existing infrastructure to their benefit and with this way get the most cost-effective usage of their old hardware.

For (SME) small and medium sized business and large organization the private cloud introduces the possibility to reduce technical support costs, reduce operating staff, increase server utilization and consolidate data centers. When cost savings are discussed Santos (2012), states that. “Cost savings are driven by standardization or automation of services or IT computer resources”. Automation and standardization reduces operation expenses and this again allows IT personnel to focus more time of giving better service to service to service to the customers itself, instead of focusing on activities that does not add any value such as configuration of software and adding disk space. (Santos 2012)

According to (Hugos and Hulitzsky 2011, 106) “Until companies are familiar with this new operating model, some may feel that external cloud environments have too many unknowns and too many risk involved.” (Hugos and Hulitzsky 2011, 106)

The Private Cloud vendors that operate out on the market is Microsoft system center, VMware vCloud Suite, Openstack Private Cloud, Amazon Virtual Private Cloud and Rackspace Private Cloud.

3.3 Hybrid Cloud

Berg (2015, 32) describes “A hybrid cloud is a combination of public cloud services and private clouds. It is not necessary to have a private cloud in order to use hybrid cloud.” The hybrid cloud environment is a mixture of on-premises data centers, virtualization and public cloud services. Hybrid cloud is usually referred to as a bridge between the private and public clouds, that has the possibility to move workloads between these infrastructures. (Berg 2015, 32).

Hugos & Hulitzsky (2011, 124) describes reason that “A company may decide to create a hybrid cloud to combine a CRM system provided on a public cloud operated by SalesForce.com with an ERP system running on their private cloud, and they may further extend this hybrid cloud by combining it with the Google cloud in order to provide their employees with the collaboration and productivity tools provided by Google Apps.” (Hugos & Hulitzsky 2011, 124)

The Hybrid Cloud helps individual companies and organizations to mix and meet their different specific IT requirements. For an organization or company that wants to deploy Hybrid Cloud into usage it is required that the infrastructure is prepared, so that the integration of Public and Private will still maintain its security and performance management performances.

The hybrid Cloud environment introduces multiple internal and external products of providers for possible deployment to organizations. With the integrity of hybrid Cloud, organizations and companies can run none-core products and applications in the public cloud itself, while the core products and applications of sensitive data are being run in the Private Cloud.

Hybrid Cloud vendors that are operating on the Cloud market are Azure, Aws Hybrid Cloud, VMware, Rackspace, EMC and HP Hybrid Cloud.

3.3.1 Advantages of using Hybrid Cloud

The Hybrid Cloud offers companies and organizations a good way to start with Cloud computing. Hybrid Cloud can quickly provide extra capacity to critical applications or services. A simple example would be providing extra capacity to companies' online shop that needs extra capacity for handle peaks during holiday seasons. As said the main application or service could run in the private Cloud, but could use cloud bursting to access additional computing resources that is need from the Public Cloud. This gives companies and organizations the possibility starting to slowly start using Cloud services. The different benefits and advantages Public Cloud can offer is that the organization or the company can use it for different purposes. Most of the cloud vendor provides robust tools for monitor and manage performance level of the Cloud.

The integration of different types of Cloud applications and in-house systems requires good security for keeping passing back and forth data in the in-house systems. The Data that is transferred back and forth between the public and private Cloud is done by data encryption and by virtual private networks.

"Cloud applications are by their nature relatively easy to integrate with other systems because they are built with well-defined application interfaces known as application programming interfaces (APIs)." (Hugos and Hulitzsky 2011, 127)

3.4 Community Cloud and advantages of usage

Berg (2015, 32) describes community clouds being the result of what private cloud is. Community cloud is only used by a partial number of organizations that offers same type of services to their end customers. These are usually nonprofit organizations such as healthcare and school that are sharing the same IT infrastructure and resources. For them this again saves costs for them through efficient IT services, which is the main idea of the community cloud. (Berg 2015, 32)

Community Cloud is defined a multiple tenancy platform that gives the possibility to be working on the same platform. The purpose of Community's Cloud is to share different Cloud computing resources that serve a common purpose or function with a reduced cost. This can be several organizations or one organization that shares common concerns regarding security, policies, regulatory needs and mission. Community Clouds are usually managed by a constituted organization or by a third party IT companies.

4 Different Cloud Services on the market

Deployment model is a description of how the IT infrastructure is deployed. (Sosinsky 2011, 39) describes “You can think of the cloud as the boundary between where a client’s network, management, and responsibilities ends and the cloud service provider’s begins.” (Sosinsky 2011, 39)

The service model does describe for the customer what is the service provider offering. Most well know service models out on the market are SaaS software as a service, PaaS platform as a service and IaaS infrastructure as a service that is referred to SPI model. Sosinsky (2011,33) says “The service models build on one another and define what a vendor must manage and what the client’s responsibility is” (Sosinsky 2011, 33)

Mell & Grance (2011) state that: National institute of standards and technology (NIST) defines that service models that exist out on the market are SaaS, PaaS and IaaS. The three Cloud services types that exists stands for: Software as a Service “SaaS”, Platform as a Service “PaaS” and Infrastructure as a Service “IaaS”. (Mell & Grance 2011)

The differences between the three Cloud services are regarding the purpose it serves and the control that users have over the information in the cloud. The different services that are delivered through cloud services is the core of what cloud computing are. The service model defines the architecture of how the applications are managed, controlled and how the users have access to the information in the cloud environment.

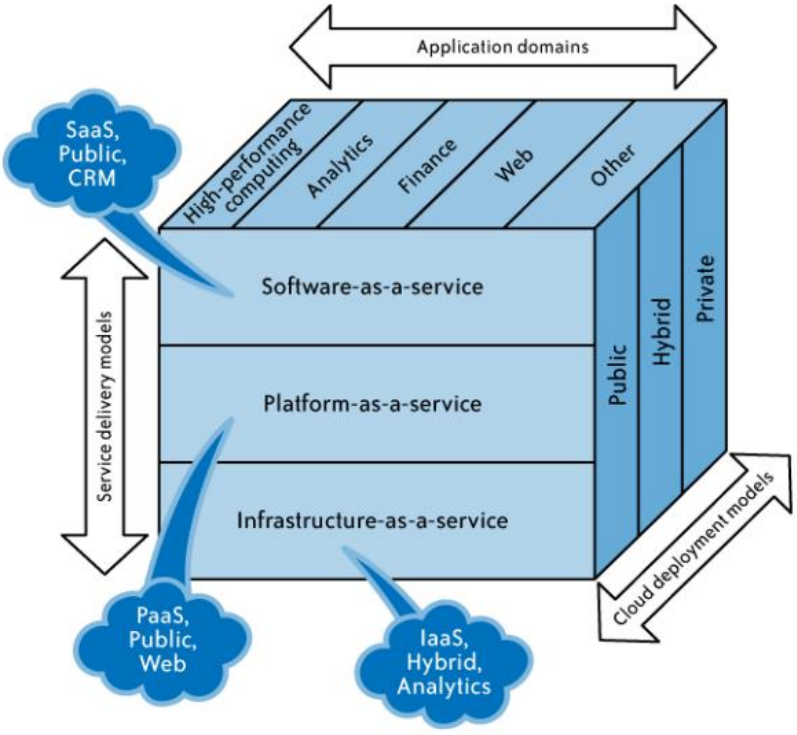

Figure 2. SPI Service model.
(Mather, T., Kumaraswamy, S. & Latif, S. 2009, 11)

What is worth mentioning that depending on if the organization or company is having an On-Premise environment, IaaS or a SaaS service. The Responsibility varies as simple as things as restoring backups and that responsibility of data. It is important that this is taken into account when choosing a Cloud service model and Cloud Deployment model. The figure 3 below show how the responsibility varies between different cloud services.

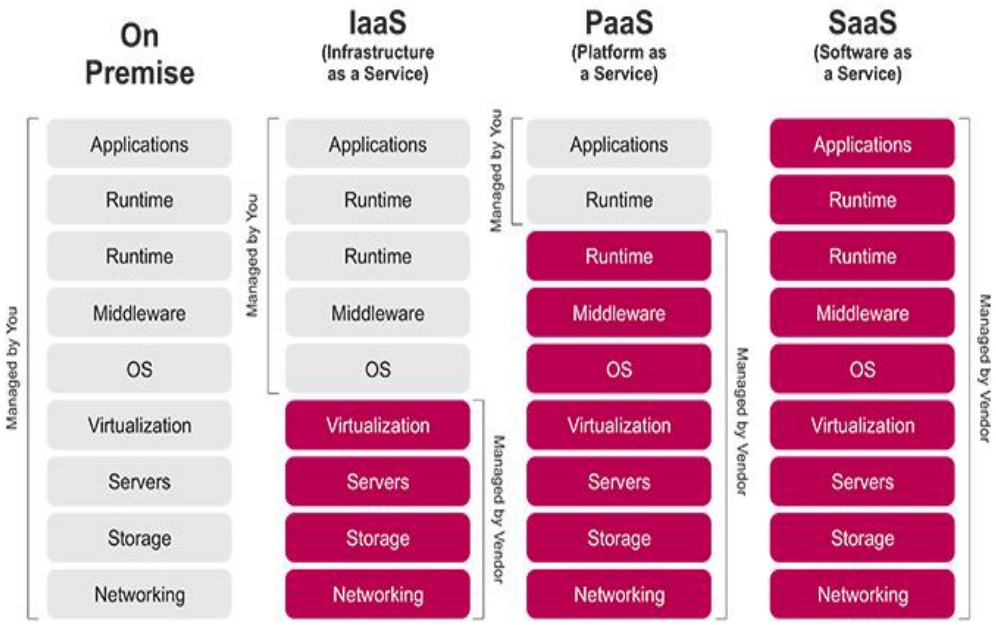

Figure 3. Vendor responsibility
(Getsix 2016)

4.1 (SaaS) Software as a Service

Collier and Shahan (2015, 24) states that, SaaS is a service where software is hosted and managed for the client. The service is based of multitenant architectures and single version application that is used by the all of the customers. SaaS has the possibility to be scaled out and in to multiple instances for ensuring the best performance, in all the locations the company or organization is operating. SaaS is licensing model works with annual and monthly subscription purpose. (Collier and Shahan 2015, 24)

When Collier and Shahan (2015, 24) are describing SaaS in today's business a good example is the Microsoft Office 365 which is typical model. "Subscribers pay a monthly or annual subscription fee, and they get Exchange as a Service (online and/or desktop Outlook), Storage as a Service (OneDrive), and the rest of the Microsoft Office Suite (online, the desktop version,

or both).” The benefit subscribers are being provided is the most recent version of the software available. Additional benefit that this provides is having a mail server Microsoft exchange without purchasing a server installing and supporting it. In the SaaS service model all of this is taken care of for you such as installing software updates and patches. (Collier and Shahan 2015, 24)

At the SaaS service model the customer do not need to maintain the application or software in their own datacenter. The customers’ only responsibility is managing their own data and everything else is managed by the vendor beginning from the application to infrastructure itself. Usually the SaaS services model is provided over the application itself through a browser for the client.

In today’s world businesses want to reduce the daily operation cost because of the bad economy and high pressure to cut down expenditures. Hugos and Hulitzsky (2011, 68) state that, “Mainframes and traditional software licenses—traditionally a significant expense for companies to maintain have become a target of cost reduction, along with the cost to maintain space for them, as well as the salaries and benefits provided to the in-house staff to operate and enhance them.” (Hugos and Hulitzsky 2011, 68)

When traditional license cost and SaaS license costs are compared, the traditional license cost structure is when the software is purchased, where after it is loaded into the hardware itself. Additional option in the traditional license cost is to buy a maintain agreement, where the software receives patches or support. In the SaaS model on the other hand there is no need for purchase the software, instead it is rented out for usage on subscription based or by as per-per-use model.

Hugos and Hulitzsky (2011, 48) states that in the recent years, “Small and medium-sized businesses have shown an appetite for purchasing software-as-a-service applications within enterprise resource planning (ERP) or CRM or supply chain management that previously were available only in traditional delivery models and affordable only to the largest of corporations.” (Hugos and Hulitzsky 2011, 48)

SaaS introduces IT personnel and business decision personnel to the following additional cost savings and benefits as: Upgradability, Resilience. Accessibility, Scalability and Cost savings. With upgradeability the cloud provider is responsible for managing your hardware and software updates. When the vendor handles this a lot of workload decreases from the IT personnel’s monthly job tasks. Resilience introduces the possibility for companies and organizations to get up and running again fast. Accessibility again gives the client the possibility to access the application simply only with a browser. Scalability makes sure that you only pay of what

you use, for example if your business starts growing you only need to add more user licenses and vice-versa. The final cost reducing aspect is that there is no longer a need for heavy investments in new IT hardware, upgrading, installing or maintaining the IT infrastructure operational costs.

Additional well know SaaS vendors out on the cloud market are Cisco Webex, MailChimp, Zendesk, Yammer, Saleforce.com CRM and Dropbox. In the figure 4 below one can view the different Cloud Service types that are offered from different cloud service types.

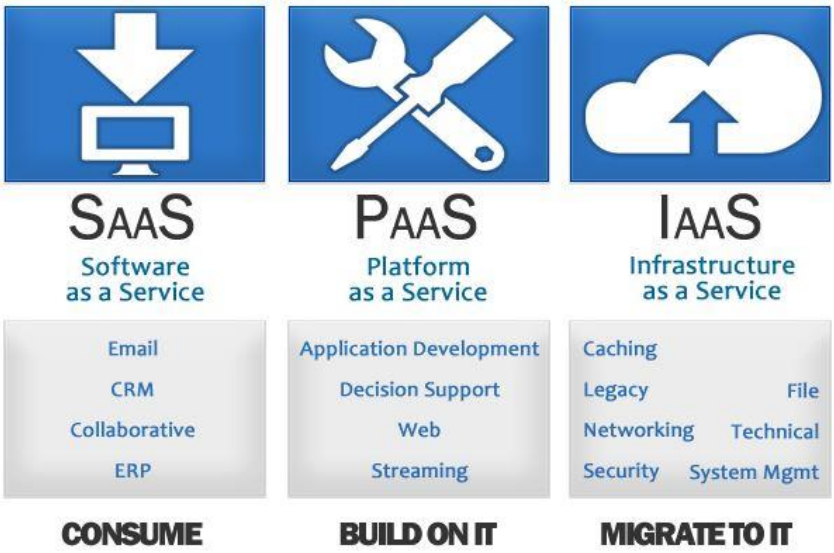

Figure 4. Cloud Services
(Ivan 2012)

4.2 (PaaS) Platform as a Service

Collier and Shahan (2015, 24) describes PaaS as deploying an application into an application hosted environment where the application is managed by the cloud vendor. The Application itself is provided by the developer and the PaaS vendor provides the need platform where it can be deployed and accessed. The programmer only needs to develop the application itself in the PaaS service model. This frees up the developer of not needing to update and managing the infrastructure, meaning more time can be focused on development. (Collier and Shahan 2015, 24)

PaaS is used as a development platform environment where you have the possibility to design, develop, test and deploy and host the different host applications in the cloud environment. The core benefit with PaaS is that there is no need to have an infrastructure for development

and testing. Because PaaS has inbuilt in the cloud already necessary needed development tools for getting the jobs done, this is why PaaS has many advantages for developers.

Mather, Kumaraswamy and Latif (2009, 39) concludes that PaaS cloud providers typically develops tools and standards for development also including also channels for payment and deployment. PaaS service providers receives their payment for providing the platform and the distribution of the services. This enables rapid deployment and low costs for developers and business owners. (Mather, Kumaraswamy and Latif 2009, 39)

Mather, Kumaraswamy and Latif (2009, 40) describes that "PaaS offers the potential for general developers to build web applications without needing specialized expertise, which allows an entire generation of Microsoft Access, Lotus Notes, and PowerBuilder developers to build web applications without too steep a learning curve." (Mather, Kumaraswamy & Latif 2009, 40)

To customers the PaaS model makes it possible to interact with the application software itself to retrieve and enter data and receive reports to the level the vendors allowing it. The benefit for the customer's perspective is that they do not need to care about the software, maintenance of the hardware or any development of the applications. The only thing the customer does need to care about is the interaction it has with the application platform. From the customer's perspective the vendor is responsible of managing all the product lifecycles, maintenance and the operational aspects of the service.

Additional benefits PaaS introduces to developers are the different operating system features. They can be upgraded and changed depending of their need and to automate daily processes. When PaaS and SaaS are compared they are closely related. The difference is that PaaS is where the provider offers the development environment as a service, where the developers are using predefined blocks of code from the vendor's inventory to create their own made applications. For developers, PaaS also introduces the possibility to much easier work geographically anywhere at different software development projects, because all the tools are web application based there is no need to install any software's to the computer itself. You can also work with any computer you want too, as also the development tools themselves are hosted in the cloud where they are easily accessed through a web browser. This again helps reducing the yearly IT costs. The cost model of PaaS has made it popular around startup companies, because there is no longer the complexity of setting up the servers and network related hardware's.

PaaS cloud services providers out on the market are Google App Engine, VMware's Spring Source, and Amazon's Amazon Web Services (AWS) are common examples of PaaS offerings.

4.3 (IaaS) Infrastructure as a Service

With the traditional hosted application model the vendor delivers the infrastructure were the client can run their applications. This usually means that there is dedicated hardware that is leased or purchased for that specific client and application only. Compared to IaaS service model the infrastructure is provided to run the application, but the cloud computing approach makes it possible to be offered as a pay per use model to scale offered services depending of the demand. The biggest cloud service providers offer IaaS platforms that monitor constantly and scales up and down depending of the demand.

Hugos and Hulitzsky (2011, 64) explains that IaaS. "Allows companies to essentially rent a data center environment without the need and worry to create and maintain the same data center footprint in their own company." (Hugos and Hulitzsky 2011, 64)

Collier & Shahan (2015, 19) Describes that IaaS manages and runs their server farms in virtualization platform. This enables the client to create virtual machines of almost any operating system such as Windows or Linux that is hosted on the vendor's IT infrastructure. (Collier & Shahan 2015, 19)

When IaaS model is discussed it is usually viewed as similar as utility computing, were the idea is offering computing services as paying only for the amount disk usage, processing power that you are actually using. Mather, Kumaraswamy & Latif (2009, 42) describes "IaaS is typically a service associated with cloud computing and refers to online services that abstract the user from the details of infrastructure, including physical computing resources, location, data partitioning, scaling, security, backup, and so on." (Mather, Kumaraswamy & Latif 2009, 42)

IaaS providers out on the cloud market are Amazon's Amazon Web Services (AWS), Azure, Rackspace, Google Compute engine and IBM SmartCloud. There is also Cloud software providers like Apache Cloudstack and Openstack that gives companies and organizations the opportunity to build an own IaaS cloud.

5 Methods

For building my theoretical background to this thesis I have done a literature review in order to deepen my knowledge base of cloud computing which was done in the previous section two to three. As mentioned earlier one of my objectives is to recommend a IT solution for company X's new infrastructure. To further enhance my knowledge about this topic I need to use

data gathering methods as Interview and internet research. Interview as a method has been used in this thesis when collecting different cost how much existing costs are and for the hosting proposal. After I have received all the data about the different IT infrastructure solutions, I will use analysis methods as comparison and evaluation to justify the best IT solution for company x. In the following section the analysis methods will be further explained.

To justify the reason why analysis methods comparison and evaluation was chosen. Is that comparison being a good method tool for using when comparing different cost between solutions. Evaluation in the other hand is a good method of usage in assessment process between different options.

5.1 Comparison

Charles (1994) describes, a comparative researcher being one inspecting similarities in patterns between many similar cases. Typical comparative research cases usually consist of fifty or more. Cases are usually limited in comparative research; the goal is to establish similarity in every case that are included in the study. (Charles, 1994)

Collier (1993) states that comparison is an important tool of analysis, “It sharpens our power of description, and plays a central role in concept-formation by bringing to focus suggestive similarities and contrasts among cases.” Usage of comparison is commonly used in suggestions in hypotheses. Where I can contribute is in the inductive breakthroughs for new hypotheses and new theory construction. (Collier, 1993)

5.2 Evaluation

Powell (2006, 1) says that “Evaluation research can be defined as a type of study that uses standard social research methods for evaluative purposes, as a specific research methodology, and as an assessment process that employs special techniques unique to the evaluation of social programs.” After reason for leading evaluation research are examined, general values are viewed and discussed. (Powell 2006, 1)

Main goal of evaluation is providing feedback that is useful to a variety of audiences, such as administrator and staff. Nowadays feedback is considered being helpful and supports the decision making process. Trochim (2000) states that “the relationship between an evaluation and its impact is not a simple one studies that seem critical sometimes fail to influence short-term decisions, and studies that initially seem to have no influence can have a delayed impact when more congenial conditions arise.” (Trochim 2000)

Trochim (2000) states that there are many sorts of different evaluations, depending of what type of subject is being evaluated and the real purpose of evaluation. In evaluation there are two types of evaluation such as formative and summative. “Formative evaluations strengthen or improve the object being evaluated they help form it by examining the delivery of the program or technology, the quality of its implementation, and the assessment of the organizational context, personnel, procedures, inputs, and so on.” Trochim (2000) explains that “Summative evaluations, in contrast, examine the effects or outcomes of some object they summarize it by describing what happens subsequent to delivery of the program or technology; assessing whether the object can be said to have caused the outcome; determining the overall impact of the causal factor beyond only the immediate target outcomes; and, estimating the relative costs associated with the object” (Trochim. 2000)

6 Case Company

It is worth mentioning in the beginning of the case company description, that as a request from the IT company that I am currently working for while I am writing my thesis, it was asked that no names or sensitive information will be revealed of the company’s client, or about the company I am working for. This also includes not revealing any person names and in which business field the case company X is operating in to be included in the thesis report. Because of this some information have been modified in this thesis to protect the real identity of case company X. The company will be called Company X in my Thesis report for who I am going to recommend a new IT Infrastructure solution for. Company Y is the company that I am currently working for.

Shortly about the company Y where I am currently working at, they offer different types of IT services such as Infrastructure development services, Implementation, Helpdesk, IT maintains and Cloud capacity services in the Uusimaa region in Finland. The company Y has been operating for over 20 years and have currently over 30 IT experts working for them.

6.1 Case Company Requirements

The current situation in the company X is that they have two physical servers. One of the physical servers has 2 virtual servers running in VMware ESXI 4.1.0 platform. The second physical server works as backup server and same time as Hyper-V manager. One of the physical server’s warranty has run out and the second one is running out during this year.
Because of the old age of the servers, company X needs to critically think about renewing them to ensure business continuity in the future. Company X does also have the same situation with their existing network firewall and switches that are in usage.

The requirements company X has for their new IT infrastructure is that it is reliable and will fulfil the company X IT infrastructure requirements for the upcoming five years. Company X ideal new IT infrastructure would be that in the in the upcoming year further IT investments would not take place. The main requirement for company X is that, they are able to reduce monthly and yearly costs and receive return of their investment. Company X is open minded for different options such as building their new IT infrastructure in hosting or the cloud. The option of buying new servers and running in the traditional way, which they have been doing for many years already has also been considered as an option.

I like to point out that in the monthly and yearly costs of the existing setup, New on-premises, hosting and IaaS azure IT proposal, some of the financial numbers have been received from Company Y representatives when interviews have been held. Based on this the conclusions have been made of the current situation and prices that exist that can vary in the future.

At the following sections will go through the existing setup, after which three new IT infrastructure proposals will be made for company X. One of them will be traditional on-premises, second running in the company's hosting environment and lastly IaaS cloud solution. Lastly the three suggestions will be compared and evaluated based on this a recommendation will be made for company's X new IT infrastructure.

6.2 Existing IT infrastructure setup in the company

SERVERS

Platform	Name	OS	Data	Data2	CPU+ Core	RAM	Roles
VMWARE	SERVER5	Windows 2008 R2	120gb		2+1	4gb	ESXI Management, NPS, Printer server
VMWARE	SERVER7	Windows 2008 R2	75gb		1+1	4gb	RODC, GPO, DHCP, DNS
Hyper-V host	SERVER6	Windows 2012 R2	931gb	932gb,195tb, 1,5tb, 3tb	4+4	22gb	Hyper-V, Veeam, Veeam offsite
Hyper-V	SERVER8	Windows 2012 R2	120gb		1+1	10gb	e-office (includes: IIS, print server, file and storage)
Hyper-V	eInvoice software	Windows 2012 R2	25gb		1+1	1gb	eInvoice software, (portal to eInvoice software application that exist on Server8 server)

Table 1: Existing server setup

Network Devices

Purpose	Mark	Model
WIFI	Aruba	Aruba IAP 215
WIFI	Aruba	Aruba IAP 215
WIFI	Aruba	Aruba IAP 215
Firewall	Sonicwall	SonicWALL NSA200
Switch	HP	ProCurve Switch 2530-24g
Switch	HP	ProCurve Switch 2530-24g
Switch	HP	ProCurve Switch 1800-24G

Table 2: Existing network setup

Physical Servers

Name	Mark	Model	Main purpose	Warranty status
SERVER5	HP	Proliant Ml350 G6	ESXI 4.1.0	23.4.2015
SERVER6	HP	Proliant Ml310e Gen8	Hyper-V	22.11.2016

Table 3: Existing Physical Servers

Backups: are handled by Veeam and backed up offsite to company Y hosting environment as part of disaster recovery plan.

Network: connection is from Nebula and has the speed 100mb down and 10mb up. The Nebula existing ISP agreement continues until further notice. In the contract there is no limit of the internet speed usage.

Disaster recovery plan: Part of their disaster recovery plan the company X has the possibility in emergency to start and run the IT environment up in Company's Y hosting. The price for running company's X existing setup in company's Y hosting is **525€** per month.

Email server: Company X belongs to a large enterprise that have many branch offices. Company X is a branch office. This is why the company does not have an own email server, the email service is provided to the company.

6.3 Costs of running the existing IT environment

Electricity: In company X existing IT environment there exist physical Ml310e Gen8 and Proliant Ml350 G6. The server Ml310e Gen8 is consuming 350W the other server ProLiant Ml350 G6 is consuming 360W per hour. Both server is consuming together 710W per hour that is equal to 0,71kW per hour. For this calculation I have used Fortum Tarkka electricity contract that average cost is 3.83 c/kWh per year.

When calculating the electricity monthly and yearly price, you need to take into consideration the local distributor's prices. In Helsinki the local distributor is Helen that costs 3.31 c/kWh up on that electricity tax is needed to been paid is 2,8c/kWh. From this the total electricity price that is 9.94 c/kWh.

Ground payment:

ground payments 4,02 euros/month from Fortum and 5,00 euros/month from Helen = **9.02** €

Calculation per day:
0,71kWh x 9,94c/kWh = 7.06 c/hour x 24 hours = 169,38 c/day divided by 100 cents = **1,70** € / day

For the calculation per month:
1,70 euro's/day x 30 days = 51 euros + 9,02 euros / month **= 60,02 €** month

For the calculation per year:
169,38 c/day divided by 100 cents divided by 100 cents = 1,70 € day x 365 days = 618,23 € year + ground payments = 9.02 € month x 12 months = 108.24 euros = **726,47** € year.

Cooling and UPS: (uninterruptible power supply) costs are a monthly fixed cost at 30 € per month. Existing UPS used in the company X server room is Eaton 5PX RT 3U, cooling is included in the monthly rent that company X is paying.

Licenses: are handled by the company's global IT company, server licenses are managed by company Y Microsoft SPLA license model that costs **90€**/month. When laptop and desktops are purchased with the Windows 7, 8 or 10 operating system. Licenses are purchased on the same time one-off purchases.

Server Room: exist in the same building employees are working. The server room cost includes to the monthly rent company is paying. Estimated price for the monthly server room costs are **132€** per month and size is 3 m2.

IT Maintenance: are done at monthly bases keeping the Windows update and software's up to date. This decreased the risk of possible security wholes and keeping the servers up to date.

Network: connection is from Nebula and has the speed 100mb down and 10mb up. The Nebula ISP agreement it's continues until further notice. In the contract there is no limit of the internet speed usage.

Monitoring: service purpose is to monitor the services, servers and network devices for potential problems. If a problem occurs for example the server is not up and running the company's, IT department will receive an email alert of the ongoing issue.

Monthly Costs	Euro
IT Maintenance	210 €
Monitoring	60 €
Cooling + UPS	30 €

Electricity	60,02 €
Network Bandwidth	159 €
Backup + Offsite backup	200 €
Server room	132 €
License costs	90 €
Monthly job tasks	150 €
Fixed monthly cost	**1091€**
Yearly cost	**13,095 €**

Table 4: Cost of running the existing setup

7 The three IT infrastructure proposals

In the company X requirements, it was mentioned that the new IT infrastructure needs to be reliable and will serve the company the upcoming five years. Their second requirement was that the company X wanted to avoid future IT investments in the near future. Based on this information following On-premises, hosting and IaaS cloud new IT infrastructure proposal have been made to company X.

7.1 New On-premises environment

For this new On-premises proposal firewall and switches will not be renewed. They will be discussed in another meeting about the renewing the Network hardware if company X decides to the new On-premises environment. For the new On-premises server I have used Build my dell (no date) when building the proposed server to company X proposal. See Figure 5 how the server looks like below.

Figure 5. Dell T630 Server
(Michell, D. 2014)

On-Premises Investment:

Physical Server	1	DELL T630 E5-2620V3 8G H730P IDRAC 16SFF	**1887.20 €**
VMware ESXI	1	vSphere Hypervisor 6.0.	**free**
Memory:	3	DELL 8GB DDR4-2133 RDIMM LV 2RX8 EEC	**435.00 €**
Power Supply	1	DELL 750W HOT-PLUG POWER SUPPLY 13G	**206.00 €**

CPU + Fan:	1	DELL POWEREDGE E5-2620 V3 CPU KIT	**439.00 €**
Heat Sink:	1	DELL T630 HEAT SINK 105W MAX	**21.40 €**
Network Card:	1	DELL BROADCOM 5720 2P 1GBE NIC, FH	**99.00 €**
Hard Drives: (6)	6	DELL 300GB 10K 6G SAS HOT-PLUG 2.5" 13G	**1195.80 €**
		Delivery costs	**17 €**
		Total Price:	**4300 €**

Table 5: On-premises Investment

Technical specification:

CPU: Intel Xeon E5-2620v3 6 core 2.4 GHz + optional two Intel Xeon E5-2620v3 CPU

Memory: DDR4-2133 RDIMM = 24GB Memory

16 pcs 2.5 SFF Hot-plug drive bays

300GB 10K RPM SAS 12Gbps 2.5in Hot-plug Hard Drive = 1.8 TB

Dell PERC H730P RAID Controller, 2GB NV Cache

Dual, Hot-plug, Redundant Power Supply (1+1), 750W, Titanium, 200-240VAC

Broadcom 5720 DP 1GB Network Interface Card

Embedded Systems Management: iDRAC8, Enterprise + 8GB vFlash

Warranty: 3-year Next Business Day Onsite Service

New On-premises IT Infrastructure renewal work:

If company X decides to take the option buying new On-premises environment there is a need to migrate the infrastructure to the new hardware. The new Virtual platform will be VMware ESXI (vSphere Hypervisor) 6.0. Were the tool Vmware vCenter Converter tool will be used to clone and migrate servers to the new environment. Servers that have existing operating system Windows 2012 R2 running will be cloned to the new environment. Servers that have 2008 R2 operating system running will be migrated to new server SERVER9 that is running in 2012 operating system.

Work Steps for installation	Cost
(5h) Installation of the new Dell hardware	475.5 €
(2h) Installation of VMware ESXI 6.0	189 €
(6h) Migration of server SERVER8	567 €
(1h) Remove SERVER6 role of Hyper-V management	100 €
(3h) Configuration and testing of UPS	283.5 €

(4h) Configuration of Veeam offsite	378 €
(2h) Installation of SERVER9	189 €
(8h) Consolidation of server SERVER5 and SERVER7 roles to SERVER9	756 €
(3h) Configuration and deployment of SERV-ER9 to production	100 €
(4h) Migration of server eInvoice software	378 €
(8h) Administrative work and planning	756 €
Total amount:	**4172 €**

Table 6: Migration Work New On-premises

Estimated Monthly and Yearly costs new On-premises

Disaster recovery plan: If company X decided on the new On-premises environment solution, they will be able to use the same disaster recovery plan as they were using in their existing setup. Even when the server amount is decreased from five to four same amount of cpu, ram and hard disk is needed which is why the plan will not change. As part of their disaster recovery plan the company x has, in case of an emergency, the possibility to start and run the IT environment up in Company's Y hosting. The price of running company's X existing setup in company's Y hosting is 740€ per month.

License costs: In the new On-premises environment there will be 4 servers running with operating system 2012 R2. The license model will be Microsoft SPLA that is handled by company Y and costs per server are **18 €** per month. That is important to point out that when laptop and desktops are purchased with the Windows 7, 8 or 10 operating system licenses. They are purchased as one-off purchases. All rest of the licenses is handled by the global IT Company.

Server Room: exist in the same building employees are working. The server room cost includes to the monthly rent the company is paying. Estimated price of the monthly server room costs are **132€** per month and size is 3 m2.

Electricity cost: In the new On-premises model the server Dell T630 E5-2620v3 8G. That is consuming 750W, which would mean that 750W/hour is 0,75kWh per hour. For this calculation I have used Fortum Tarkka contract that average cost is 3.83 c/kWh per year. When calculating the electricity prices, you need to take into consideration the local distributor's prices. In Helsinki the distributor is Helen that costs 3.31c/kWh and electricity tax is needed to be paid that is 2,8c/kWh. From this the total electricity price is 9.93 c/kWh.

Ground payment per month:
ground payments 4,02 euros/month from Fortum and 5,00 euros/month from Helen = **9.02** €

Calculation per day:

9,94c/kWh = 7,46c/hour x 24 hours = 179,04 c/day divided by 100 cents = **1,79** €/day

Calculation per month:

1,79 € day x 30 days = 53,70 € + 9,02 €/month ground payments = **62,72 €** month

For the calculation per year:

1,79 €/day x 365 days = 653,35 euros/ year + ground payments 108,24 euros/year = **761,59 €** year

IT Maintenance: are done on a monthly basis, keeping the Windows update and software's up to date. This decreased the risk of possible security wholes and keeping the servers up to date.

Monitoring: service purpose is to monitor the services, servers and network devices of potential problems. If a problem occurs for example the server is not up and running the company's, IT department will receive an email alert of the ongoing issue.

Network: connection is from Nebula and has the speed 100mb down and 10mb up. The Nebula ISP agreement it's continues until further notice. In the contract there is no limit of the internet speed usage.

Estimated Fixed Monthly costs	
IT Maintenance	280 €
Monitoring	150 €
Backup + Offsite	200 €
Electricity (750W)	62,72 €
Licenses	72€
Network Bandwidth	159 €
Server Room	159 €
Cooling + UPS	30 €
Total amount	**1113 €**

Table 7: New On-premises Estimated Fixed Monthly Costs

Estimated Yearly costs for new On-premises environment	
1 Year (includes investment + work steps + Fixed monthly costs)	21 825.04 €
2 Year (includes fixed monthly cost for 1 year)	13 352.64 €
3 Year (includes fixed monthly cost for 1 year)	13 352.64 €
4 Year (includes fixed monthly cost for 1 year)	13 352.64 €
5 Year (includes fixed monthly cost for 1 year)	13 352.64 €

Total Amount:	**75 235.60€**

Table 8: New On-premises Yearly Costs

7.2 Company Y Hosting IT infrastructure environment

In this proposal the Company X will move their existing IT infrastructure to Company Y hosting environment. Only employees from Company X will have access to the data and company Y specific IT employees. The benefit company X will receive from this is that they do not need to invest at any physical server hardware. It is however necessary that a new firewall is purchased, for being able to handle the increased traffic flow between Hosting Y datacenter and company X office.

For this proposal company X has the possibility to use the hosting Y IT infrastructure capacity services. This gives the possibility to adjust things as adding more hard disk space, cpu and ram or removing servers as quickly they are no longer needed. In the hosting proposal the server licenses will be handled by Company Y as user SPLA based from Microsoft volume license model.

Investment	
Cisco ASA 5506 (Firewall)	**700 €**
	Total Amount: 700 €

Table 9: Hosting Investment

Technical Specification

Below are brief technical specifications of company Y hosting environment. Because of security reason some of the information is not revealed as a request from the company Y representative's security policy.

Summary of data center solutions:

- Duplexed UPS system and UPS diesel generators
- Duplexed air conditioning
- Mechanical Protection against structural changes
- Duplicated operator level data communications
- Camera surveillance
- Access control systems with biometric fingerprint sensors to enter location
- Fire, water and pressure resistant cable entry system

Company Y IT infrastructure equipment's:

- 2pcs of IBM Storwize V3700 SAN device
- server cluster is operated by Multiple IBM x3550M4 servers that is all the time available for usage

- Multiplied 10GB network connection to the main switch
- Redundant High-availability (stateful active-active) Cisco ASA firewall solution

New Hosting IT Infrastructure renewal work:

If company X decides going with the proposal moving their old, IT infrastructure to company Y hosting environment. They need to migrate and renew some of the existing servers when moving to the company y hosting environment. Virtual platform for the hosting environment will be VMware ESXI (vSphere Hypervisor**)** 6.0. The tool Vmware vCenter Converter tool will be used to migrate and clone the Windows server 2012 server's SERVER8 and eInvoice software. First to an USB hard drive which after they will be imported to the new VMware hosting environment.

Servers that have 2008 R2 operating system will have their roles migrated. To the new server Server9 that will be created and have the server 2012 R2 operating system running. Server Server6 will not be migrated or consolidated in this hosting proposal. The reason for this is that server is only running backup application Veeam. That takes of backups and backup's offsite and servers warranty is soon running out. Server9 will take care of Veeam backups on disk and backups offsite in the new hosting environment.

Work Steps for installation	Cost
(4h) Installation and configuration of Cisco ASA 5506 (Firewall for company X office)	473 €
(2h) Installation and configuration of Hosting Y environment capacity services	189 €
(3h) Migration of server SERVER8 (Hyper-V)	284 €
(1h) Remove SERVER6 role of Hyper-V management	100 €
(3h) Migration of server EINVOICE SOFTWARE	284 €
(3h) Configuration of Veeam offsite	284 €
(3h) Installation of SERVER9	400 €
(6h) Consolidation of server SERVER5 and SERVER7 roles to SERVER9 server	567 €
(4h) Administrative work and planning	378 €
Total Amount:	**2,957 €**

Table 10: Hosting Migration Work

Estimated Monthly and Yearly Costs of Hosting

Capacity Services: The price for this services are based on following numbers below. The calculated need is 500GB Hard disk, 6 core cpu and 20gb of ram, that is equal to 740**€/**month. Monthly price will be changed if the company wants to add or reduce server resources.

Disaster recovery plan: In the hosting environment solution, there is a need to change the disaster recovery plan to adjust to the new hosting needs. Backups and backups offsite is

handled by company Y in this proposal and part of their disaster recovery plan. The company X has the possibility, in emergency or disaster start and run their IT environment up in another datacenter in Company's Y hosting. The price for running company's X existing setup in company's Y hosting is 740**€** per month.

License costs: in the hosting license model will be that in the hosting environment there will be running 4 servers with operating system 2012 R2. The license model will be Microsoft SPLA that is handled by company Y and cost per server are **18 €** per month. That is important to point out that when laptop and desktops are purchased with the Windows 7, 8 or 10 operating system licenses. They are purchased as one-off purchases all rest of the licenses is handled by the global IT Company.

Electricity, Cooling, Server Room and UPS cost: This cost is reduced to **30€** per month. The reason for this is that company Y is able to divide the costs, in their datacenter hosting environment with other companies.

Network: Even when the company X in this example would move to company's Y hosting there is still a need for a network bandwidth in the office. The existing ISP provider is from Nebula and has the speed 100mb down and 10mb up. The Nebula ISP agreement it's continues until further notice. In the contract there is no limit of the internet speed usage.

IT Maintenance: are done on a monthly bases keeping the Windows update and software's up to date. This decreased the risk of possible security wholes and keeping the servers up to date.

Monitoring: service purpose is to monitor the services, servers and network devices of potential problems. If a problem occurs for example the server is not up and running the company's, IT department will receive an email alert of the ongoing issue.

Estimated Fixed Monthly Costs	
IT Maintenance	210 €
Monitoring	100 €
Capacity Services	740 €
Backup Offsite	200 €
Network Bandwidth	159 €
Licenses	72 €
Electricity + Cooling + UPS + Server Room	30 €
Total amount	**1,511 €**

Table 11: Hosting Estimated Fixed Monthly Costs

Estimated Yearly costs for new hosting environment

1 Year (includes investment + work steps + Fixed monthly costs)	21 789 €
2 Year (includes fixed monthly cost for 1 year)	18 132 €
3 Year (includes fixed monthly cost for 1 year)	18 132 €
4 Year (includes fixed monthly cost for 1 year)	18 132 €
5 Year (includes fixed monthly cost for 1 year)	18 132 €
Total Amount	**94 317 €**

Table 12: Hosting Estimated Yearly costs

7.3 IaaS cloud IT environment

For the last IT infrastructure proposal for the case company X is the Azure IaaS cloud solution. Benefits IaaS cloud offers the company X is that they do not need to make any huge investments such as buying servers. In the IaaS cloud IT infrastructure model the company X is only paying for what they use similar to as previous Hosting proposal.

As mentioned earlier for this proposal the company X only need to pay for what they use. For this setup proposal different Azure virtual machines, vpn, licensing, backup and disaster recovery plan will be selected that will be described in greater details in upcoming sections. In the IaaS cloud proposal, the Windows server licenses will be included in the Azure virtual machine monthly cost itself.

Investment

In this proposal the Company X will move their existing IT infrastructure to Azure IaaS cloud. Only employees from Company X will have access to the data and company Y specific IT employees. The benefit company X will receive from this is that they do not need to invest in any physical server hardware. It is however necessary that a new firewall is purchased, to be able to handle the increased traffic flow between Azure datacenter and company X office.

A reduced cost for company X in this proposal is that the licensing costs are included in the Azure virtual machine as cost per-minute. Virtual machines are charges based of the resource size in IaaS azure datacenter.

Investment	
Cisco ASA 5506	**700 €**
	Total Amount: 700 €

Table 13: IaaS Cloud Investment

Technical specification

For this proposal Azure IaaS services are provided for company X IT infrastructure as 24/7 hours of service for 365 days a year. When searching online for specific technical specification of what server and network hardware is used in Azure datacenter cloud, the only information revealed on Azure website is that they use pre-configured server racks in their Azure cloud environment.

New IaaS IT infrastructure renewal work

If company X decides move their existing, IT infrastructure to the IaaS Azure cloud, the tool Microsoft virtual machine converter will be used, to migrate and clone the Windows servers' 2012 servers Server8 and eInvoice software.

Servers that have 2008 R2 operating system will have their roles migrated to the new server Server9 that will be created and have the server 2012 R2 operating system running. Server Server6 will not be migrated or consolidated to IaaS cloud environment. The reason for this is that server is only running backup application Veeam that takes of backups into disk and backups offsite. When the server is moved to the Azure IaaS cloud the backup and disaster recovery solution will be replaced by a new system. Because of this Server6 will be removed from service.

Work Steps for installation	Cost
(4h) Installation and configuration of Cisco ASA 5506 (Firewall for company X office)	473 €
(2h) Configuration of Azure IaaS cloud	189 €
(3h) Migration of server SERVER8	284 €
(1h) Remove SERVER6 role of Hyper-V management	100 €
(3h) Migration of server Einvoice SOFTWARE	284 €
(3h) Configuration of Azure backup offsite	284 €
(3h) Installation of SERVER9	400 €
(6h) Consolidation of server SERVER5 and SERVER7 roles to SERVER9 server	567 €
(4h) Administrative work and planning	378 €
Total Amount:	**2,957 €**

Table 14: IaaS Cloud Migration

Azure Infrastructure setup for company X

For building up the IT infrastructure, network and vpn tunnel I used Azures price calculator on their website to determine the monthly fixed costs and setup needed.

Service type	Custom name	Region	Description	Estimated Cost

Virtual Machines	Virtual Machine Einvoice Software	North Europe	1 standard virtual machine(s) Windows type, a1 size, 744 hours	€56.47
Virtual Machines	Virtual Machine Server9	North Europe	1 standard virtual machine(s) Windows type, a3 size, 744 hours	€225.87
Virtual Machines	Virtual Machine Server8	North Europe	1 standard virtual machine(s) Windows type, a5 size, 744 hours	€188.22
VPN Gateway	VPN Gateway	North Europe	static dynamic tier, 744 gateway hour(s), 500 GB outbound vpn	€58.90
VPN Gateway	VPN Gateway	North Europe	static dynamic tier, 744 gateway hour(s), 100 GB outbound internet	€25.54
Storage	Storage	North Europe	500 GB storage block type.	€8.46
Backup	Backup	North Europe	3 instances 50-500GB, 500 GB grs of storage	€45.54
IP Addresses	IP Addresses	North Europe	classic type, 1 instance-level	€2.51
Support			Standard level	€252.99
			Monthly Total:	**€864.50**

Table 15: IaaS Cloud IT infrastructure Setup

Estimated Monthly and Yearly cost in Azure IaaS

In this proposal model company X does not need to pay for electricity, cooling, server room and UPS cost. The reason behind this is that this is included in the Azure datacenter pricing costs.

Backup: In this new IaaS Azure cloud solution there is need to reconfigure the backup plans compared to hosting and On-premises environments. In this IT infrastructure model, the company will use the azure backup solution taking the whole virtual machines with the GRS replication function. This gives us the possibility to restore the whole virtual machine back to existing or another datacenter. For this backup solution there is a need for a backup vault like Geo-Redundant Storage, and this solution will also work as disaster recovery plan for the company X.

Myers (2016) describes, "Geo-redundant storage (GRS) replicates your data to a secondary region that is hundreds of miles away from the primary region." If the storage account that you are using in Azure have GRS enabled, the data is able to recover from damage if a big disaster happens in the region were the main datacenter data is located. (Myers. 2016)

Offsite backup: Even if the company is backing up all the whole virtual machine itself, they still want to backup individual files to have the possibility to restore them. This functionality requires azures file-folder backup solution. This will also work with Geo-redundant storage solution keeping the data in several datacenters.

VPN Gateway: A vpn tunnel is needed between Azure IaaS datacenter and Company X office to being able to use the products and software's. This also includes for the Global IT company.

IP addresses: one public is needed for being able to access Einvoice Software from outside the company network.

License costs: In the azure IaaS model the Windows license is included in the azure virtual machine itself. The charging base is per minute cost as monthly pay as you go principle. In the calculations in the fixed monthly costs the azure virtual machines are calculated as 744 hours of continuous usage.

Network: Even if the company X in this example would move to company's Y hosting, there is still a need for a network bandwidth in the office. The existing ISP provider is from Nebula and has the speed 100mb down and 10mb up. The Nebula ISP agreement it's continues until further notice. In the contract there is no limit of the internet speed usage.

Support: This support option is for that company Y is able to receive assistance from Microsoft engineer team if they are not able to resolve or troubleshoot the issue themselves. To be clear the support plan helps Company Y have reduced business impact in their environment.

IT Maintenance: are done on a monthly basis keeping the Windows update and software's up to date. This decreased the risk of possible security wholes and keeping the servers up to date.

Monitoring: service purpose is to monitor the services, servers and network devices of potential problems. If a problem occurs for example the server is not up and running the company's, IT department will receive an email alert of the ongoing issue.

Estimated Fixed Monthly costs	
IT Maintenance	210 €
Monitoring	100 €
Azure IT infrastructure costs	864,50 €
Network Bandwidth	159 €
Total amount	**1333,50 €**

Table 16: IaaS Cloud Estimated Fixed Monthly Costs

Estimated Yearly costs for IaaS Cloud environment	
1 Year (includes investment + work steps + Fixed monthly costs)	19 661 €
2 Year (includes fixed monthly cost for 1 year)	16 002 €
3 Year (includes fixed monthly cost for 1 year)	16 002 €
4 Year (includes fixed monthly cost for 1 year)	16 002 €
5 Year (includes fixed monthly cost for 1 year)	16 002 €
Total Amount	**83 669 €**

Table 17: IaaS Cloud Estimated Yearly Costs

8 Conclusion

One of this thesis aims were to increase the understating of cloud computing, for any person or company that wants to familiarize themselves about the subject. Defining what is cloud computing and what it is able to offer in terms of benefits to run IT infrastructure in. This Aim was successfully accomplished between the pages eight to twenty-two, were general cloud computing concepts as deployment methods and cloud service models were discussed. The second aim for my thesis was to help company Y to support the IT strategy of company X. This aim will be fulfilled in the recommendation section part that is the last part of this thesis.

When the objectives of this thesis are reviewed the purpose was to evaluate the cost of renewing the existing IT infrastructure for company X. This also included listing the current sta-

tus of warranties expiration date, license, traffic, fixed cost (server room) and electricity costs for existing IT infrastructure. This Following Objective was fulfilled between pages 25-32.

Additional objectives that were fulfilled during writing this thesis were, finding the cost of operating the business in company's Y hosting environment and in Azure IaaS cloud and to find out the charging basis for Azure traffic, storage and availability.

In the two final sections I will present a data analysis the data analysis about the three IT proposals that were made for company's X new IT infrastructure proposal. Lastly these three IT proposals will be compared and evaluated and based off this a final recommendation will be made for company X new IT infrastructure. This concludes the final objective for this thesis.

8.1 Data Analysis

In this part I will analyze the data from the three IT infrastructure proposals that include estimated investing, monthly and yearly costs, that was collected as a basis for doing the final recommendation to company X.

The three IT proposals for company X were a new On-premises, Hosting and IaaS Azure cloud. These IT proposals are compared with a five-year plan cost perspective. The cheapest plan when viewing the cost directly is the new On-premises with five-year total amount is **75 235.60 €.** Second one is the IaaS Azure Cloud that's five-year total amount is **83 669 €.** The most expensive IT infrastructure solution for company is the Company Y hosting environment for company X with a five years' total amount is **94 317 €.**

Starting evaluating these three IT infrastructures proposals, is the new On-premises actually the most cost effective solution in the long run? What is important to take into consideration with the new On-premises that the hardware's life length maximum is three to five year. This means that after five years the company needs to invest into new server hardware to replace the old one. This again of course adds more costs when the old hardware needs to be replaced. After the new server hardware has been purchased the job of migrating work needs to be done to the new hardware which consumes resources. This can also potentially create downtime in services for the end users when the services are transferred. Another evaluation perspective that is important to also take into consideration, is that if the company starts growing rapidly there is a chance the new server that was purchased not long ago is no longer able to keep up with all the hard drive, cpu and ram that is suddenly needed for running the new company's IT requirements.

The second part of the evaluation that needs to be discussed is about the hosting Y IT proposal for company X. From the three proposals based on the cost this was the most expensive one in the five-year plan for company X. It is important to remember that you cannot always look only at the numbers and get the whole perspective based on this. For companies their IT security policies is really important aspect to consider if a hosting solution is actually a really a good solution for them. The reason behind all of this is that company X still has all the data and servers are owned by them even that they are hosted. Additional benefits that company X receives are that they only need to pay for the cpu, hard disk and memory used in monthly bases. This means that they are able to reduce or increase server and resources as they want. Another cost reducing aspect on the long run is that Hosting eliminates the need to invest in new servers and hardware after three to five years.

As the last IT proposal IaaS Cloud will be evaluated as a solution for Company X new IT infrastructure. From the three IT proposals for Company's X new IT infrastructure this one is the second cheapest option. Actually this is the cheapest option in fact even if initially the numbers would suggest that it is the second cheapest option when the cost is compared by five years. The reason for this is that when moving to the cloud you only pay for what you use on a monthly charging basis. This gives the company the possibility to reduce and increase resources as they are needed similar as in hosting. For companies that are operating in many continents with IaaS cloud they have the possibility to run in multiple datacenters for providing high availability. As a last cost reducing aspect company X will have with running the IaaS azure cloud is that they do not need to invest in any hardware in the near future. Similarly to what the hosting capacity service would provide company X, they only need to pay for what they use for example in terms cpu, disk space and ram, charged on a monthly basis.

8.2 Recommendation

In the data analysis part all three IT proposal was evaluated and compared. The conclusion was that IaaS azure is the cheapest and best long term solution for company X. This solution will save them the hassle every five year of renewing the server hardware and migrating.

To justify a recommendation for the company X new IT infrastructure, it's needed to rewind to the discussion in the data analysis part. Based on the findings the following recommendation is concluded to act as a proposal for company X new IT infrastructure. IaaS Azure cloud is able to provide better benefits in the long run even after five years in service for the company. When a company has taken into usage cloud service, this lowers the barrier to introduce SaaS or PaaS services into usage. This is why this is the best solution for company's new IT infrastructure to run in.

However, it is important again to remember that for those companies that are not able to go to the Cloud computing because of their IT policies, it is highly recommended to consider hosting as their new IT infrastructure instead of buying new server hardware for their On-premises environment. This is simply because they do not need to invest in any new server hardware after three to five years when the server equipment needs to be renewed.

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Illustrations

Figures

Tables

Appendixes

Appendix 1: The appendix titles are written by clicking the “Insert Caption”-button found in the References tab